Version: 2.0

DO-IT-AUTO

BATTERY ANALYZER
USER'S MANUAL

Battery Analyzer Series

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1.0 - Introduction

1.1-The Product:

This Battery Analyzer is designed to test the condition of the automotive battery using conductance method. Unlike the conventional method of draining the battery by applying resistance load to it and obtain the result from the meter gauge; this analyzer utilizes a series of pulsed voltage across the battery cells and observes the AC current that flows in response to it.

The benefits of this test method are:

- *Conductance correlates directly to the battery capacity*
- *Passive testing method is safe.*
- *Never discharges or drain the battery.*
- *Able to test condition of discharged battery.*
- *Consistent and repeatable results.*
- *Provides unique indication of battery conditions.*

Besides, this analyzer also provides check the Alternator's charging and Starter's cranking conditions.

It is maintenance free and no internal batteries required. It powers up when connected to the battery posts during testing.

The operation is fast and simple. When hooked up to the battery posts, the displayed instructions on the screen will lead you through and a warning tone to caution you to perform the correct steps.

Its result is consistent and repeatable and can be performed numerous times without heating up the unit. It is very safe as it does not create any sparks when connected to the battery terminals during testing on the vehicle.

1.2 Specifications:

Operating Voltage:	*9V ~ 15V (max)*	
Analyzing Capacity (Amps):	*CCA*	*100 ~ 1700*
	EN	*100 ~ 1000*
	IEC	*100 ~ 1700*
	DIN	*100 ~ 1000*
	JIS#	*(100 ~ 1700 CCA)*
Battery analyzing time:	*Less than 5 seconds.*	

2.0 Safety Measures:

For safety reasons, read this manual thoroughly before operating the Tool.

Always refer to and follow the safety instructions and testing procedures provided by the car or equipment manufacturer. The safety messages presented below and throughout this user's manual are reminders to the operator to exercise extreme care when using this test instrument.

2.1 Safety Precautions:

⚠DANGER

When the engine is running, it produces carbon monoxide, a toxic and poisonous gas. Always operate the vehicle in a well ventilated area. Do not breathe exhaust gases – they are hazardous that can lead to death.

⚠CAUTION

To protect your eyes from propellant object such as caustic liquids, always wear safety eye protection.

⚠DANGER

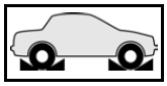
Fuel and battery vapors are highly flammable.
DO NOT SMOKE NEAR THE VEHICLE DURING TESTING.

⚠CAUTION

When engine is running, many parts (such as pulleys, coolant fan, belts, etc) turn at high speed. To avoid serious injury, always be alert and keep a safe distance from these parts.

⚠WARNING

Before starting the engine for testing or trouble shooting, always make sure the parking brakes is firmly engaged. Put the transmission in Park (automatic transmission) and Neutral (manual transmission).



⚠WARNING

Always block the drive wheels.
Never leave vehicle unattended while testing.

⚠CAUTION

Never lay tools on vehicle battery. You may short the terminals together causing harm to yourself, the tools or the battery.

⚠CAUTION

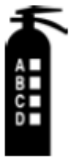
Engine parts become very hot when engine is running. To prevent severe burns, avoid contact with hot engine parts.

⚠WARNING

Do not wear loose clothing or jewelry while working on engine. Loose clothing can get caught in fan, pulleys, belts, etc. Jewelry can conduct current and can cause severe burns if comes in contact between power source and ground.

⚠CAUTION

When the engine is running, be cautious when working around the ignition coil, distributor cap, ignition wires and spark plugs. They are HIGH VOLTAGE components that can cause electrical Shock.



IMPORTANT

Always keep a fire extinguisher readily available and easily accessible in the workshop.

2.2 Other Precautions:

- This battery analyzer is meant for testing of 12 Volts batteries only.

- Its operating voltage is from 9V ~ 15V DC and should not be tested on 24V directly. It will cause damage the unit. For 12V x 2 batteries (in series or parallel), disconnect the connections and test them individually.

- Battery that has just been charged by the charger contains surface charge and it should be discharged by turning ON the Head lights for 3~5 minutes before testing.

- Always attached the analyzer clips on the lead side of the battery terminal posts during testing so that it has a good contact. This will provide better and accurate results.

- Do not attach the analyzer clips directly onto the steel bolt that tightened to the battery terminal posts; this may give inaccurate readings or inconsistent results. (Note: This also applies to all other battery testing methods.)

- If the battery terminal posts were oxidized or badly corroded and the connections were bad, the analyzer will prompt you to check the connections. In this case, clean the terminal posts and performs testing directly on the terminal posts it-self.

- During testing on the battery whist it is still in the car, make sure the engine is OFF.

3.0 Working with Batteries

CAUTION

Lead-acid batteries contain a sulfuric acid electrolyte, which is a highly corrosive poison and will produce gasses when recharged and explode if ignited. This will hurt you--BAD!

When working with batteries, you need to have plenty of ventilation, remove your jewelry, wear protective eyewear (safety glasses) and clothing, and exercise caution.

Do not allow battery electrolyte to mix with salt water. Even small quantities of this combination will produce chorine gas that can KILL you!

Whenever possible, please follow the manufacturer's instructions for testing, jumping, installing, charging and equalizing batteries.

DANGER/POISON
SHIELD EYES
EXPLOSIVE GASES CAN CAUSE BLINDNESS OR INJURY
NO
• SPARKS
• FLAMES
• SMOKING
SULFURIC ACID
CAN CAUSE BLINDNESS OR SEVERE BURNS
FLUSH EYES IMMEDIATELY WITH WATER
GET MEDICAL HELP FAST
KEEP OUT OF THE REACH OF CHILDREN. DO NOT TIP. KEEP VENT CAPS TIGHT AND LEVEL.

- Never disconnect a battery cable from a vehicle with the engine running because the battery acts like a filter for the electrical system.

  Unfiltered [pulsating DC] electricity can damage expensive electronic components, e.g., emissions computer, radio, charging system, etc.

  Turn off all electrical switches and components, turn off the ignition and then disconnect the battery.

- For non-sealed batteries, check the electrolyte level. Make sure it is covering the plates, and it is not frozen before starting to recharge.

- Do not add distilled water if the electrolyte is covering the top of the plates because during the recharging process, it will warm and expand. After recharging has been completed, recheck the level.

- Reinstall the vent caps BEFORE recharging, recharge ONLY in well-ventilated areas, and wear protective eye ware.

  Do NOT smoke or cause sparks or flames while the battery is being recharged because batteries give off explosive gasses.

- If your battery is an AGM or a sealed flooded type, do NOT recharge with current ABOVE 12% of the battery's RC rating (or 20% of the ampere-hour rating).

  Gel cells should be charged over a 20-hour period and never over the manufacturer's recommended level or over 14.1 VDC.

- Follow the battery and charger manufacturer's procedures for connecting and disconnecting cables and other steps to minimize the possibility of an explosion or incorrectly charging the battery.

  You should turn the charger OFF before connecting or disconnecting cables to a battery.

  Do not wiggle the cable clamps while the battery is recharging, because a spark might occur, and this could cause an explosion. Good ventilation or a fan is recommended to disperse the gasses created by the recharging process.

- If a battery becomes hot, over 110° F (43.3° C), or violent gassing or spewing of electrolyte occurs, turn the charger off temporarily or reduce the charging rate.

- Ensure that charging with the battery in the car with an external MANUAL charger will not damage the vehicle's electrical system with high voltages.

  If this is even a remote possibility, then disconnect the vehicle's battery cables from the battery BEFORE connecting the charger.

4.0 – Types of Batteries

Basically the major types of batteries are as follows:

- ***Starting Battery***

  Sometimes it is called SLI (Starting, Lighting and Ignition) battery and it is designed to start and run engines. It delivers quick bursts of energy (such as starting engines) and have a greater plate count.

  The plates will also be thinner and are composed of a Lead "sponge", similar in appearance to a very fine foam sponge. This gives a very large surface area, but if deep cycled, this sponge will quickly be consumed and fall to the bottom of the cells.

  Automotive batteries will generally fail after 30-150 deep cycles if deep cycled, while they may last for thousands of cycles in normal starting use (2-5% discharge).

  Starting batteries are usually rated at "CCA", or cold cranking amps, or "MCA", Marine cranking amps - the same as "CA".

- ***Deep Cycle Battery***

  These batteries are used mainly on golf cart, scooter, solar, RV, etc has less instant energy but greater long-term energy delivery.

  They are designed to be discharged down as much as 80% time after time, and have much thicker plates. The major difference between a true deep cycle battery and others is that the plates are SOLID Lead plates - not sponge.

  Deep cycle batteries are usually rated at “AH” or Amperes Hour.

- **Marine Battery**

  These batteries are usually actually a "hybrid", and fall between the starting and deep-cycle batteries. The plates may be composed of Lead sponge, but it is coarser and heavier than that used in starting batteries.

  "Hybrid" types should not be discharged more than 50%.

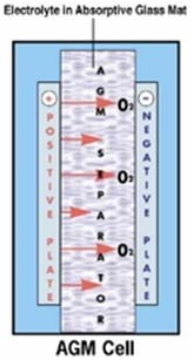
Major types of battery construction:

- **Wet Cell (Flooded)**

Wet or Flooded cell batteries are divided into low maintenance (the most common) and maintenance free (or sealed), which is based on their plate formulation.

Low maintenance batteries have lead-antimony/antimony or lead-antimony/calcium (dual alloy or hybrid) plates thus the maintenance free batteries use lead-calcium/calcium.

- **AGM**



The Absorbed Glass Matt (AGM) are also sometimes called "starved electrolyte" or "dry", because its fiberglass mat is only 95% saturated with Sulfuric acid and there is no excess liquid.

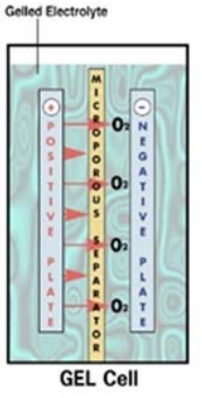
This construction allows the electrolyte to be suspended in close proximity with the plate's active material. In theory, this enhances both the discharge and recharge efficiency.

Nearly all AGM batteries are sealed valve regulated (commonly referred to as "VRLA" - Valve Regulated Lead-Acid).

Most valves regulated are under some pressure - 1 to 4 psi at sea level.

Popular usages are high performance engine starting, power sports, deep cycle, solar and storage battery.

- **GEL Cell**



The Gel Cell is similar to the AGM style because the electrolyte is suspended, but it is different because technically the AGM battery is still considered to be a wet cell. The electrolyte in a GEL cell has a silica additive that causes it to set up or stiffen.

All Gel Cell batteries are sealed and a few are "valve regulated", which means that a tiny valve keeps a slight positive pressure.

The recharge voltages on this type of cell are lower than the other styles of lead acid battery. This is probably the most sensitive cell in terms of adverse reactions to over-voltage charging. If the incorrect battery charger is used on a Gel Cell battery, poor performance and premature failure is certain.

Gel Cell batteries are best used in VERY DEEP cycle application and may last a bit longer in hot weather applications.

The Gel Cell and the AGM batteries are specialty batteries. They store very well and do not tend to sulfate or degrade as easily as Wet Cell.

Also, there is little chance of a hydrogen gas explosion or corrosion when using these batteries which made them the safest lead acid batteries.

5.0 - The Battery Analyzer

5.1 - Main Unit

Figure 1

5.2 - Keypad Functions:

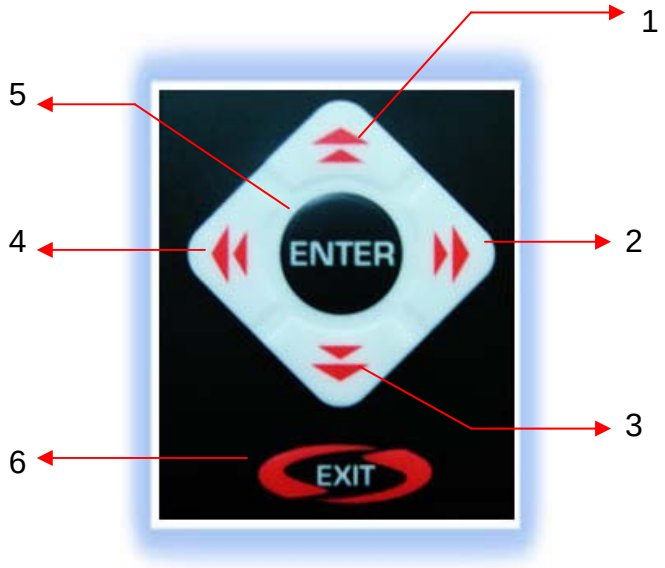


Figure 2

5.2.1 Functions of Individual key:

1. Use this key to scroll up to the next item OR when it is in the keying-in Battery Ratings values mode, press this key once will increase the value by step of 5 units.

2. Use this key to shift the selection tab to the right item OR when it is in the keying-in Battery Ratings values mode, press this key once will increase the value by step of 100 units.

3. Use this key to scroll down to the next item OR when it is in the keying-in Battery Ratings values mode, press this key once will decrease the value by step of 5 units.

4. Use this key to shift the selection tab to the left item OR when it is in the keying-in Battery Ratings values mode, press this key once will decrease the value by step of 100 units.

5. Press this key will ENTER into the selected function.

6. To EXIT, press this key once will return back to the previous screen.

6.0 - Battery Diagnosis

6.1 – Start Analyzing

This battery analyzer can perform testing while the battery is still fixed on the vehicle. Please make sure the engine is OFF.

1. Attach the clips onto the battery terminal posts and the battery analyzer will power up and lights up the LCD display screen as shown (Fig.3).

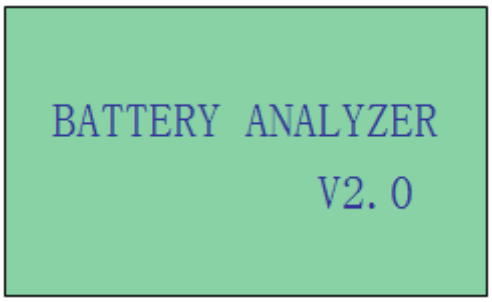


Figure 3

2. It will run through a self-test and when completed it displays the Main Menu as shown: (Fig. 4)

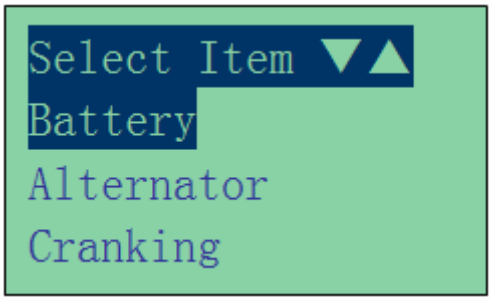


Figure 4

3. Pressing key once will scroll down to the next item if there is a need to select it.

6. As an example (Fig.4) the selected item was on “Battery” and it is being highlighted.

7. Press ENTER key will proceed to do the battery testing and if it has detected any surface voltage on the battery, it will start to clean and a message is shown (Fig. 5) below.

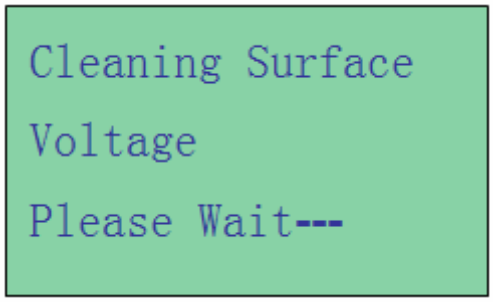


Figure 5

8. If the surface voltage is too great for the Analyzer to handle, it will prompt you with the instructions as shown: (Fig.6) below

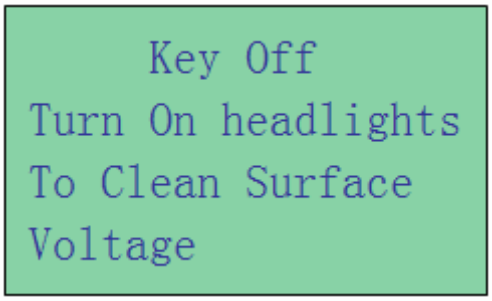


Figure 6

9. Wait until the surface voltage cleaning had completed, the analyzer will advise as follows: (Fig.7) and then press ENTER key.

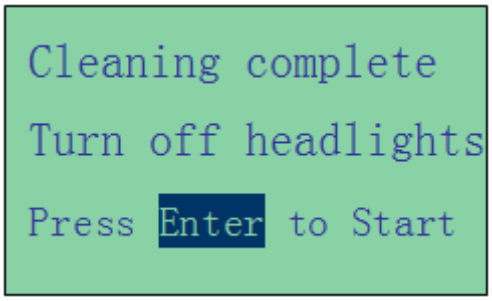


Figure 7

4. If there is no surface voltage, then it will straight away enter into “Select Input” menu screen as shown in Fig. 8

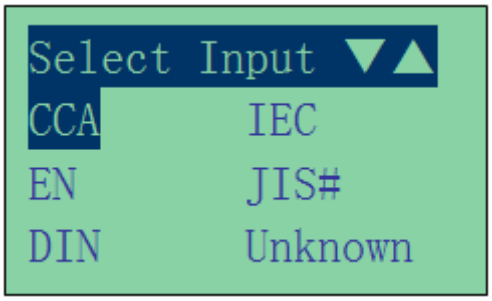
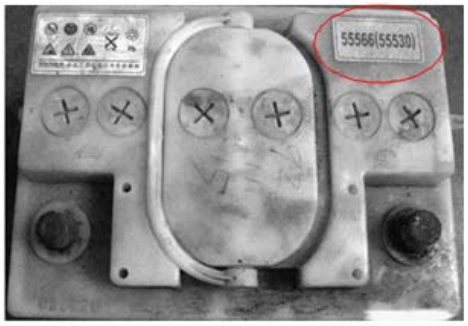
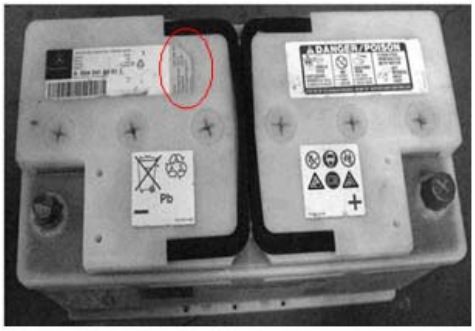


Figure 8

8. Before selecting the ratings ‘CCA, EN, IEC, and DIN & JIS #’ from the menu, check the battery specification value. This value can be checked on the battery labels as some of the examples shown below:





If it is selected under JIS # (Japanese Industrial Standard) then the display will prompt you as shown (Fig.9) below.

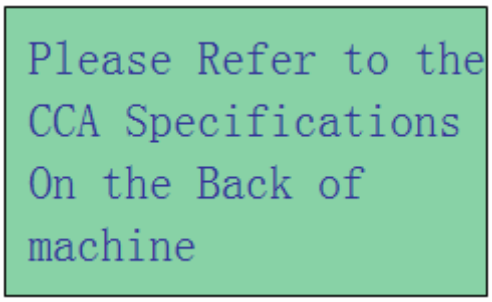


Figure 9

Refer to the battery model (example: 80D26L or NX110-5L) on the Cold Cranking Amps (CCA) Table list either at the back of the Analyzer or from this manual on page 35 (See example Fig.10 below.)

Battery Model (JIS#)		CCA			Battery Model (JIS#)		CCA		
NEW	OLD	WET	MF	CMF SMF	NEW	OLD	WET	MF	CMF SMF
50D20R		310	380	480	80D26L	NX110-5L	580	580	630
50D20L		310	380	480	85B60K				500
50D23R	85BR60K	500			85BR60K				500
50D23L	85B60K	500			95D31R	NX120-7	620	660	850
50D24R	NT80-S6	390			95D31L	NX120-7L	620	660	850
50B24L	NT80-S6L	390			95E41R	N100	515	640	770
50D26R	50D20R		370		95E41L	N100L	515	640	770

Figure 10

Press

key and the display will show: (Fig.11) below

Figure 11

9. Referring to the Table list (Fig.10) under 80D26L, check the battery type: WET, MF, Sealed MF or Closed MF (CMF) as each category has different CCA ratings. For instance, if the battery is a Sealed MF (CMF) then it is rated at 630 CCA.

Note: *WET - Wet Cell Type*
MF - Maintenance Free Type
CMF - Closed or Sealed Maintenance Free

10. To enter the value 630, press key will increase the original value of 500 (Fig.11) by step of 100 units to 600. Likewise use key to increase the last two digits (00) to 30 by step of 5 units for each pressing. (Fig. 12)

Figure 12

11. Once the CCA rating of the battery is confirmed, press

key will start the testing process. Refer to the display below (Fig. 13).

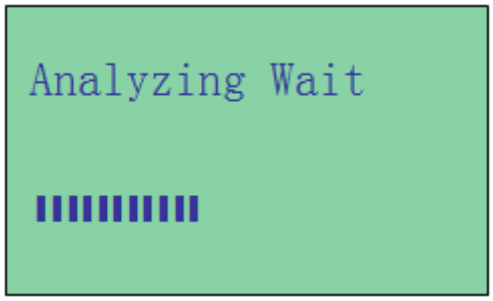


Figure 13

12. For less than 5 seconds, the results of the testing will be displayed on the LCD screen. (Fig. 14)

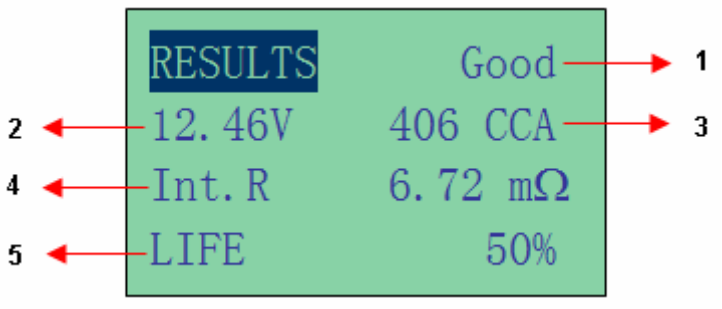


Figure 14

Interpretations of the above results:

1. **RESULTS:** **Good**
   A very straight forward display of the final results basing on the evaluation of the tested condition. 'Good' indicates the battery in good condition. 'Replace' indicates that the battery needs to be replaced. If not, the battery will fail anytime without any warning.

2. **Voltage :** **12.46V**
   This indicates the tested battery voltage (12.46V). It depends on the state of charge on the battery:

100% fully charged	-	13.20V
90% charged	-	12.90V
75% charged	-	12.45V

3. **CCA (Cold Cranking Amps):** **406 CCA**
   CCA ratings has been used here, therefore the tested result is in 406 CCA. If other rating (DIN or JIS, or IEC, or EN) were selected, it will base on the respective rating to calculate and show the results in that selected rating.

4. **Int. R (Internal Resistance):** **6.72mΩ**
   In normal condition, the internal resistance should fall between 2.0 mΩ ~ 15.0 mΩ. As a matter of fact, the higher the battery CCA readings obtained the lower the internal resistance should be.

5. **LIFE:** **50 %**
   This is an indication of the battery life expectancy in percentage. If the life falls below 45 %, the RESULT will display "Replace" and it is time to change to a new battery.

Explanation of the following terms used as shown on the LCD display:

- **CCA (Cold Cranking Amps) – most commonly used Standard.**
  CCA is a rating used in the battery industry to rate a battery's ability to start an engine in cold temperatures. This rating is the number of amperes that a new fully charged battery can delivery at 0°F (-18°C) for 30 seconds, while maintaining a voltage of at least 7.2 Volts for a 12V battery.

  The bigger the CCA will have the greater starting power of the battery.

- **IEC (International Electrotechnical Commission) Standard.**
  IEC amperes rating require that at 0°F (-18°C), the number of amperes that the 12V battery can deliver while maintaining a voltage of at least of 8.4 Volts for 60 seconds during cranking.

- **EN (European Norms) Standard**
  EN amperes rating require that at 0°F (-18°C), the number of ampere that the 12V battery can deliver while maintaining a voltage of at least 6.0 Volts for 180 seconds during cranking.

- **JIS# (Japanese Industrial Standard)**
  JIS # amperes' rating is based on Ampere Hours and is calculated using 20 hours rating. In this manual, it is using CCA ratings reference table list provided basing on the JIS model number (See page 34).

- **DIN (Deutsches Institut für Normung)** - German Institute for Standardization.
  Taking an example: DIN 100 Amperes
  Basing on DIN 100 Amp battery, the rating requires that at 0°F (-18°C), the battery is able to deliver 100 amperes while maintaining a voltage of at least of 9.0 Volts for 30 seconds and 8.0 Volts for 150 seconds during cranking.

- **Unknown**
  If you are not sure which ratings (CCA, EN, IEC, JIS or DIN) that the battery is based on then choose this setting. It will show the battery's Voltage, CCA and the Internal Resistance (mΩ) only. This selection can also be used to test 12V - Deep Cycle Batteries.

  An example of the results display is shown below:

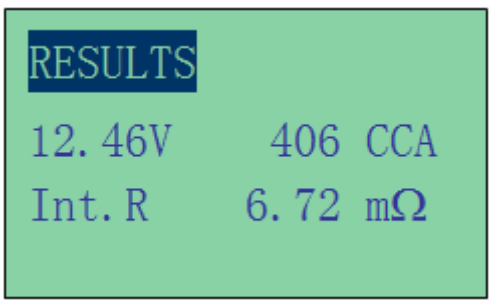


Figure 15

Use **Voltage** (*should not fall below 12.6V when fully charged*) and the Internal Resistance [**Int.R**] (*should not more 15mΩ*) readings to determine the condition of the tested Deep Cycle Battery.

Batteries that had been left idle for long periods can still be tested with this analyzer. To perform the test, just clamp the analyzer clips onto the battery terminals and it will display the screen (Fig.16) as shown if its voltage falls below the normal 12 volts and a buzzing sound is heard.

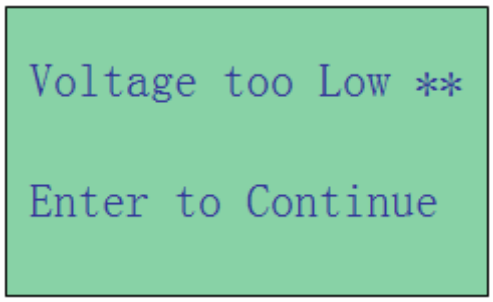


Figure 16

Press

key to continue and the display will show: (Fig.17)

Figure 17

Check the battery ratings and enter it as described in step 10 (page 13) and the results will show as an example below:

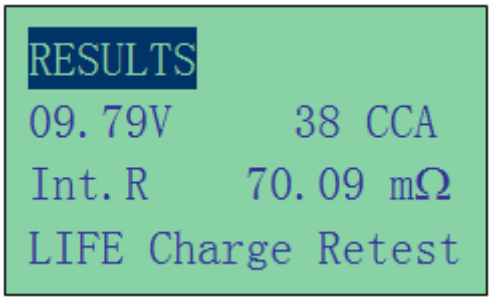


Figure 18

You will notice that there is no indication of message (Good or Replace) on the RESULTS instead on LIFE; it indicates “Charge Retest”. Recharge the battery fully and repeat the test again.

13. Pressing the

key at any moment will exit and return back to the previous screen.

7.0 – False Capacity

A battery can meet all the tests for being at full charge, yet be much lower than its original capacity. If plates are damaged, sulfated, or partially gone from long use, the battery may give the appearance of being fully charged, but in reality acts like a battery of much smaller size.

This same thing can occur in GEL Cells if they are overcharged and gaps or bubbles occur in the gel. What is left of the plates may be fully functional, but with only 20% of the plates left...

Batteries usually go bad for other reasons before reaching this point, but it is something to be aware of if your batteries seem to test OK but lack capacity and go dead very quickly under load.

8.0 – Amperes-Hour (AH) Rating

All Deep Cycle batteries are rated in amp-hours (AH). An amp-hour is one amp for one hour, or 10 amps for 1/10 of an hour and so forth. It is Amps multiply (x) by Hours.

For example, if you have something that draws 20 amps, and you use it for 20 minutes, then the amp-hours used would be 20 (amps) x .333 (hours), or 6.67 AH.

The ‘*20 Hour Rate*’ is the accepted AH rating time period for batteries used in solar electric and backup power systems (and also for nearly all Deep Cycle batteries).

This means that it is discharged down to 10.5 volts over a 20 hour period while the total actual amp-hours that it supplies are measured. Sometimes ratings at the *6 hour rate* and *100 hour rate* are also given for comparison and for different applications.

The *6 hour rate* is often used for industrial batteries, as that is a typical daily duty cycle. Sometimes the *100 hour rate* is given just to make the battery look

better than it really is, but it is also useful for figuring battery capacity for long-term backup Amperes-Hour (AH) requirements.

Amperes-Hour (AH) is specified at a particular rate because of something called the Peukert Effect. The Peukert value is directly related to the internal resistance of the battery. The higher the internal resistance, the higher the losses while charging and discharging, especially at higher currents.

This means that the faster a battery is used (discharged), the LOWER the AH capacity. Conversely, if it is drained slower, the AH capacity is higher.

9.0 – State Of Charge (SOC)

State of charge (SOC), or conversely, the depth of discharge (DOD) can be determined by measuring the voltage and/or the specific gravity of the acid with a hydrometer. This will NOT tell you how good (capacity in AH) the battery condition is - only a sustained *Load Test* can do that.

Voltage on a fully charged battery will read 2.12 to 2.15 volts per cell, or 12.7 volts for a 12 volt battery. At 50% the reading will be 2.03 VPC (Volts Per Cell), and at 0% will be 1.75 VPC or less.

Specific gravity will be about 1.265 for a fully charged cell, and 1.13 or less for a totally discharged cell.

Many batteries are sealed, and hydrometer reading cannot be taken, so you must rely on voltage measurement.

Hydrometer readings may not tell the whole story, as it takes a while for the acid to get mixed up in wet cells.

If measured right after charging, you might see 1.27 at the top of the cell, even though it is much less at the bottom. This does not apply to gelled or AGM batteries.

9.1 Measuring the State Of Charge (SOC)

If the battery's electrolyte is above 110° F (43.3° C), allow it to cool down.

To determine the battery's state-of-charge with the battery's electrolyte temperature at 80° F (26.7° C), use the following table below.

The table assumes that a 1.265 specific gravity reading is for a fully charged, Wet Cell, Lead Acid battery.

For other electrolyte temperatures, use the Temperature Compensation table below to adjust the Open Circuit Voltage or Specific Gravity readings.

The Open Circuit Voltage will vary for GEL Cell and AGM type batteries, so check the manufacturer's specifications.

Digital Voltmeter Open Circuit Voltage	Approximate State-of-Charge	Hydrometer Average Cell Specific Gravity	Electrolyte Freeze Point
12.65 V	100%	1.265	-75° F (-59.4° C)
12.45 V	75%	1.225	-55° F (-48.3° C)
12.24 V	50%	1.190	-34° F (-36.7° C)
12.06 V	25%	1.155	-16° F (-26.7° C)
11.89 V	Discharged	1.120	-10° F (-23.3° C)

STATE-OF-CHARGE

[Source: BCI]

Electrolyte Temperature Fahrenheit (°F)	Electrolyte Temperature Celsius (°C)	Add or Subtract to Hydrometer's SG Reading	Add or Subtract to Digital Voltmeter's Reading
160°	71.1°	+.032	+.192 V
150°	65.6°	+.028	+.168 V
140°	60.0°	+.024	+.144 V
130°	54.4°	+.020	+.120 V
120°	48.9°	+.016	+.096 V
110°	43.3°	+.012	+.072 V
100°	37.8°	+.008	+.048 V
90°	32.2°	+.004	+.024 V
80°	**26.7°**	**0**	**0 V**
70°	21.1°	-.004	-.024 V
60°	15.6°	-.008	-.048 V
50°	10°	-.012	-.072 V
40°	4.4°	-.016	-.096 V
30°	-1.1°	-.020	-.120 V
20°	-6.7°	-.024	-.144 V
10°	-12.2°	-.028	-.168 V
0°	-17.8°	-.032	-.192 V

9.2 Temperature Compensation

Electrolyte temperature compensation is depending on the battery manufacturer's recommendations and will vary.

When using a non-temperature compensated HYDROMETER, make the adjustments referring to the table above.

For example:

At 30° F (-1.1° C), the specific gravity reading would be (1.265 – 0.020) **1.245** for a 100% State-of-Charge.

At 100° F (37.8° C), the specific gravity would be (1.265 + 0.008) **1.273** for 100% State-of- Charge.

This is why using a temperature compensated hydrometer is highly recommended and more accurate than other means.

If you are using a DIGITAL VOLTMETER, make the adjustments indicated in the table above.

For example:

At 30° F (-1.1° C), the voltage would be (12.65 – 0.120) **12.53 V** for a 100% State-of-Charge.

At 100° F (37.8° C), the voltage would be (12.65 + 0.048) **12.698 V** for 100% State-of-Charge.

For non-sealed batteries, check the specific gravity in each cell with a hydrometer and average the readings.

For sealed batteries, measure the Open Circuit Voltage across the battery terminals with an accurate digital voltmeter. This is the only way you can determine the State-of-Charge (SOC).

Some batteries have a built-in hydrometer, which only measures the State-of-Charge in one of its six cells.

If the built-in indicator is clear or light yellow, then the battery has a low electrolyte level and should be refilled and recharged before proceeding.

If sealed, the battery is toast and should be replaced. If the State-of-Charge is below 75% using either the specific gravity or voltage test or the built-in hydrometer indicates bad (usually dark), then the battery needs to be recharged before proceeding.

You should replace the battery, if one or more of the following conditions occur:

- If there is a .05 (sometimes expressed as 50 points) or more difference in the specific gravity reading between the highest and lowest cell, you have a weak or dead cell(s). If you are really lucky, applying an **EQUALIZING** charge may correct this condition. (See Equalizing Charge – page 26)
- If the battery will not recharge to a 75% or more state-of-charge level or if the built-in hydrometer (LED display) still does not indicate green (which is 65% state-of-charge or better).
- If digital voltmeter result indicates 0 volts, you have an open cell.
- If the digital voltmeter or the battery analyzer's results indicates 10.45 to 10.65 volts, you probably have a shorted cell or a severely discharged battery. A shorted cell is caused by plates touching, sediment (mud) build-up or treeing between the plates.

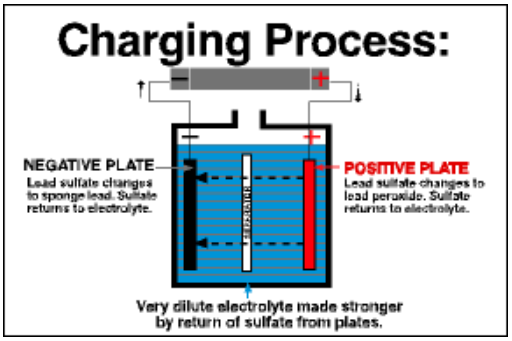
If you know that a battery has spilled or bubbled over and the electrolyte has been replaced with water, you can replace the old electrolyte with new electrolyte and recharge again.

Battery electrolyte is a mixture of 25% sulfuric acid and distilled water.

10.0 – Recharging Batteries

Battery charging takes place in the following 4-basic stages:

- *Bulk*
- *Absorption*
- *Equalizing*
- *Float*


Charging Process:
NEGATIVE PLATE
Lead sulfate changes to sponge lead. Sulfate returns to electrolyte.
POSITIVE PLATE
Lead sulfate changes to lead peroxide. Sulfate returns to electrolyte.
Very dilute electrolyte made stronger by return of sulfate from plates.

10.1 Bulk Charge (1st Stage)

Current is sent to batteries at the maximum safe rate which is accepted until voltage rises to near (80-90%) full charge level.

Voltages at this stage typically range from 10.5 volts to 15 volts.

There is no "correct" voltage for bulk charging, but there may be limits on the maximum current that the battery and/or wiring can take.

10.2 Absorption Charge (2nd Stage)

Voltage remains constant and current gradually tapers off as internal resistance increases during charging.

It is during this stage that the charger puts out maximum voltage. Voltages at this stage are typically around 14.2 to 15.5 volts.

10.3 Equalizing Charge (3rd Stage)

This optional equalizing phase is a controlled 5% overcharge, which equalizes and balances the voltage and specific gravity in each cell, the effect of increasing the charge voltage.

Equalizing reverses the build-up of chemical effects like stratification, where acid concentration is greater at the bottom of the battery. It also helps to remove sulfate crystals that might have built up on the plates.

The frequency recommendation varies by manufacturer from once a month to once a year, from 10 to 100 deep cycles, or when a specific gravity difference between cells reaches .03 (or 30 points).

To equalize a battery, fully recharge it; next, increase the charging voltage to the manufacturer's recommendations (if you cannot find one, add 5%). Heavy gassing should start occurring at this stage (be very careful about safety precautions).

Take specific gravity readings in each cell once every hour. Equalization has occurred once the specific gravity values no longer rise during the gassing stage.

10.4 Float Charge (4th Stage)

After batteries reach full charge, charging voltage is reduced to a lower level (typically 12.8 to 13.2) to reduce gassing and prolong battery life. This is often referred to as a maintenance or trickle charge, since its main purpose is to keep an already charged battery from discharging.

Charger with PWM, or "pulse width modulation" accomplishes the same thing. In PWM, the controller or charger senses tiny voltage drops in the battery and sends very short charging cycles (pulses) to the battery.

This may occur several hundred times per minute. It is called "pulse width" because the width of the pulses may vary from a few microseconds to several seconds.

NOTE: *For long term float charging, such as backup power systems that are seldom discharged, the float voltage should be set around 13.02 to 13.20 volts.*

10.5 Charging Voltage and Current

Most garage and consumer (automotive) type battery chargers are bulk charge only, and have little (if any) voltage regulation. They are fine for a quick boost to low batteries, but do not to leave them on charging for long periods.

Use an external Constant Current charger, which is set not to deliver more than 12% of the Reserve Capacity (RC) rating of the battery and monitor the State-Of-Charge (SOC). Timers that will cut-off the charger when charging hours are completed will help prevent overcharging of the battery.

NOTE:

Reserve Capacity (RC) is the number of minutes a fully charged battery at 80° F (26.7° C) is discharged at 25 amps before the voltage falls below 10.5 volts. To convert Reserve Capacity (RC) to Ampere-Hours (AH) at the 25 amps rate, multiple RC by .4167.

For discharged batteries, the following table lists the recommended battery charging rates and times:

Reserve Capacity (RC) Rating	Slow Charge (RECOMMENDED)	Fast Charge
80 Minutes or less [32 Ampere-Hours or less]	15 Hours @ 3 Amps	5 Hours @ 10 Amps
80 to 125 Minutes [32 to 50 Ampere-Hours]	21 Hours @ 4 Amps	7.5 Hours @ 10 Amps
125 to 170 Minutes [50 to 68 Ampere-Hours]	22 Hours @ 5 Amps	10 Hours @ 10 Amps
170 to 250 Minutes [68 to 100 Ampere-Hours]	23 Hours @ 6 Amps	7.5 Hours @ 20 Amps
Above 250 Minutes [over 100 Ampere-Hours]	24 Hours @ 10 Amps	6 Hours @ 40 Amps

The best method is to slowly recharge the battery at 70° F (21.1° C) over a 10 to 20 hour period *(C/10 to C/20)**using an external constant voltage (or tapered current charger) because the acid has more time to penetrate the plates and there is less mechanical stress on the plates.

***NOTE:**

C-rate is a measurement of the charge or discharge of battery overtime. It is expressed as the Capacity of the battery divided by the number of hours to recharge or discharge the battery.

For example, assume that the Amperes-Hour capacity of the battery is 220 AH, then it would take 11 hours (220 divided by 20) to recharge or discharge the battery using a C/20 rate.

For a Constant Voltage charger, apply regulated voltage at approximately 13.8 to 16 volts and should be based on the manufacturer's recommendations and temperature.

A 10 Amps Constant Voltage charger is suitable for most simple recharging or charging applications.

More expensive three-stage microprocessor controlled chargers are also available that will automatically provide bulk, absorption and float charging. A four-stage charger will provide an equalizing charge in addition to the bulk, absorption and float charging.

An excellent automatic Constant Voltage battery charger is a 15-volt regulated power supply adjusted to the manufacturer's recommendations or, if not available, refers to voltage ranges below which were based on the electrolyte temperature at 70° F (21.1° C).

Battery Type	Charging Voltage	Float Voltage	Equalizing Voltage
Wet Low Maintenance	14.4	13.2	15.1
Wet Maintenance Free	14.8	13.4	15.5
Sealed &VRLA	14.4	13.2	15.1
AGM	14.4	13.6	15.5
Gel Cell	14.1	13.2	N/A
Wet Deep Cycle	14.5	13.2	15.8

NOTE:

To compensate for electrolyte temperature, which has a negative temperature compensation coefficient, adjust the charging voltage .0028 (2.8 millivolts) to .0033 (3.3 millivolts) volts per cell per degree F.

*For example, if the temperature is 30° F (-1.1° C), then **increase** the charging voltage to 15.19 volts for a wet low maintenance battery.*

*If 100° F (43.3° C), then **decrease** the charging voltage to 13.81 volts.*

If left unattended, cheap, unregulated trickle or manual battery chargers can overcharge your battery because they can decompose the water out of the electrolyte.

Avoid using fast, high rate, or boost chargers on any battery that is sulfated or deeply discharged. The electrolyte should **NEVER** bubble violently while recharging because high currents only create heat and excess explosive gasses.

Most flooded (Wet Cell) batteries should be charged at no more than the "C/8" rate for any sustained period.

Note: *"C/8" is the battery capacity at the 20-hour rate divided by 8. For a 220 AH battery, this would equal 26 Amps.*

GEL Cells batteries should be charged at no more than the C/20 rate, or 5% of their AH capacity.

Charging at 15.5 volts will give you a 100% charge on Lead-Acid batteries. Once the charging voltage reaches 2.583 volts per cell, charging should stop or be reduced to a trickle charge.

Note:

*Flooded or Wet Cell batteries **MUST** bubble (gas) somewhat to insure a full charge, and to mix the electrolyte.*

Float voltage for Lead-Acid batteries should be about 2.15 to 2.23 volts per cell, or about 12.9 to 13.4 volts for a 12 volt battery. At higher temperatures (over 85 degrees F) this should be reduced to about 2.10 volts per cell.

NEVER ADD ACID to a battery except to replace spilled liquid. Distilled or de-ionized water should be used to top off non-sealed batteries.

Float and charging voltages for GEL Cell batteries are usually about 2/10th volt less than for flooded to reduce water loss.

Flooded or Wet Cell battery life can be extended if an equalizing charge is applied every 10 to 40 days. This is a charge that is about 10% higher than normal full charge voltage, and is applied for about 2 to 16 hours.

This makes sure that all the cells are equally charged, and the gas bubbles mix the electrolyte. If the liquid in standard wet cells is not mixed, the electrolyte becomes "stratified". You can have very strong solution at the top and very weak at the bottom of the cell.

With stratification, you can test a battery with a hydrometer and get readings that are quite a ways off. If you cannot equalize for some reason, you should let the battery sit for at least 24 hours and then use the hydrometer.

AGM and GEL Cell should be equalized 2-4 times a year at most. Please check the manufacturer's recommendations, especially on GEL Cell ones.

11.0 – Removal of Surface Charge

Surface charge is the uneven mixture of sulfuric acid and water within the surface of the plates as a result of charging or discharging. It will make a weak battery appear good or a good battery appears bad.

To eliminate the surface charge, use one of the following methods:

- Allow the battery to sit for four to twelve hours to allow for the surface charge to dissipate.
- Apply a load that is 33% of the Ampere-Hour (AH) capacity for five minutes and wait five to ten minutes.
- With a battery load tester, apply a load of at least one half the battery's CCA rating for 15 seconds and wait five to ten minutes.

12.0 – How to Revive a Sulfated Battery?

Lead sulfation occurs when a lead sulfate compound is deposited on the lead electrodes of a storage battery; this is a problem if the lead sulfate compound cannot be converted back into charged material and is created when discharged batteries stand for a long time.

When the state-of-charge (SOC) drops below 80%, the plates become coated with a hard and dense layer of lead sulfate, which fill up the pores. The positive plates will be light brown and the negative plates will be dull off-white. Over time, the battery loses capacity and cannot be recharged.

12.1 Light Sulfation

Apply a constant current from one to two amps for 48 to 120 hours at 14.4 VDC, depending on the electrolyte temperature and capacity of the battery. Cycle (discharge to 50% and recharge) the battery a couple of times and test capacity.

You might have to increase the voltage in order to break down the hard lead sulfate crystals. If the battery gets above 110° F (43.3° C) then stop charging and allow the battery to cool down before continuing.

12.2. Heavy Sulfation

Replace the electrolyte with distilled water, let stand for one hour, apply a constant current of four amps at 13.8 VDC until there is no additional rise in specific gravity.

Remove the old electrolyte, wash the sediment out, replace with fresh electrolyte, and recharge. If the specific gravity exceeds 1.300, then remove the old electrolyte, wash the sediment out, and start over with distilled water.

If the battery electrolyte rises above 110° F (43.3° C), then stop charging and allow the battery to cool down before continuing. Cycle (discharge to 50% and recharge) the battery a couple of times and test capacity.

The sulfate crystals are more soluble in distilled water than in electrolyte. As they are dissolved, the sulfate is converted back into sulfuric acid and the specific gravity rises. These techniques will only work with some batteries.

13.0 – Common Causes of Battery Failures

The most common causes of premature battery failures are:

1. Loss of electrolyte due to heat or overcharging.
2. Lead sulfation in storage.
3. Undercharging.
4. Old age (positive plate shedding)
5. Excessive vibration.
6. Freezing or high temperatures.
7. Using tap water which causes calcium sulfation.
8. Positive grid corrosion or growth due to high temperatures.
9. Fast recharging at rates greater than C/10.

14.0 – Myth about Batteries

1. **Driving a car will fully recharge a battery?**

   Some of factors affecting a car charging system's ability to charge a battery are: how much current from the alternator is diverted to the battery to charge it, how long the current is available and the temperature.
   Generally, idling the engine or on short stop-and-go trips during bad or hot weather or at night will not recharge a battery. A long daytime trip in warm weather should recharge a battery.

2. **Testing of the alternator by disconnecting the battery while the engine is running.**

   A battery acts like a voltage stabilizer or filter to the pulsating DC produced by the charging system.

   Disconnecting a battery while the engine is running can destroy sensitive electronic components, for example, emission computer, audio system, cell phone, alarm system, etc., or even the charging system itself.

   These damages can occur because the voltage can rise to 40 volts or more.

   In the 1970s, removing a battery terminal was an accepted practice to test charging systems of that era. That is not the case today. Just say **NO** if anyone suggests this.

3. **Maintenance Free (MF) batteries never require maintenance?**

   In hot climates, water in the electrolyte is decomposed due to the high temperatures and normal charging of a wet maintenance free battery. Water can also be lost due to excessive charging voltage or charging currents.

   Non-sealed batteries are recommended in hot climates so they can be refilled with distilled water when this occurs.

4. **A battery will not lose its charge while kept in storage.**

   Depending on the type of battery, it has natural self-discharge or internal electrochemical leakage at a 1% to 15% rate per month that will cause it to become sulfated and fully discharged over time.

   Higher temperatures accelerate this process. A battery stored at 95° F (35° C) will self discharge twice as fast than one at 75° F (23.9° C).

5. A battery will not explode.

Recharging a wet lead-acid battery normally produces hydrogen and oxygen gasses. While spark retarding vent caps help prevent battery explosions, they do occur when jumping, connecting or disconnecting charger or battery cables, and starting the engine. While not fatal, battery explosions cause thousands of eye and burn injuries each year.

When battery explosions occur when starting an engine, here is the usual sequence of events:

- One or more cells had a high concentration of hydrogen gas *(above 4.1%)* because the vent cap was clogged or a defective valve did not release the gas.
- The electrolyte levels fell below the top of the plates due to high under hood temperatures, overcharging, or poor maintenance.
- A low resistive bridge or treeing formed between the top of the plates such that when the current started to flow, it caused an arc or spark in one of the cells.

That combination of events ignites the gas, blows the battery case cover off and spatters electrolyte all over the engine compartment. The largest number of battery explosions while starting an engine occurs in hot climates.

When an explosion happens, thoroughly rinse the engine compartment with water, and then wash it with a solution of one-pound baking soda to one gallon of warm water to neutralize the residual battery acid. Then thoroughly rewash the engine compartment with water.

Working on well ventilated areas or using Valve Regulated Lead Acid (AGM or gel cell) type batteries can significantly reduce the possibility of battery explosions.

6. Batteries last longer in hot climates than in cold ones.

Not really, in hot climates batteries only last approximately two thirds as long compared to cold ones. Heat kills batteries, especially sealed wet lead acid batteries.

7. Pulse chargers, aspirins or additives will revive sulfated batteries.

Using pulse chargers or additives is a very controversial subject. Most battery experts agree that there is no conclusive proof that more expensive pulse charges work any better than constant voltage chargers to remove sulfation. They also agree that there is no evidence that additives or even aspirins provide any long-term benefits.

8. **Deep cycle batteries have a memory effect.**

   Lead acid deep cycle batteries do not have the so called memory effect that first generation Ni-Cad batteries have.

9. **On really cold days turn your headlights on to warm up the battery up before starting your engine.**

   While there is no doubt that turning on your headlights will increase the current flow in a car battery; it also consumes valuable capacity that could be used to start the engine. Therefore, this is not recommended.

   For extremely cold temperatures, externally powered battery warmers, battery blankets, or engine block heaters are highly recommended.

   AGM and Ni-Cad batteries perform better in extremely cold temperatures than wet cell batteries.

15.0 – Battery Ratings Charts

15.1 Japanese Industrial Standard (JIS#) Ratings

Battery Model (JIS#)		CCA			Battery Model (JIS#)		CCA		
NEW	OLD	WET	MF	CMF SMF	NEW	OLD	WET	MF	CMF SMF
26A17R		200			36B20R	NS40Z	275	300	360
26A17L		200			36B20L	NS40ZL	275	300	360
26A19R	12N24-4	200	220	264	36B20RS	NS40ZS	275	300	360
26A19L	12N24-3	200	220	264	36B20LS	NS40ZLS	275	300	360
28A19R	NT50-N24	250			38B20R	NX60-N24	330	340	410
28A19L	NT50-N24L	250			38B20RS	NT60-N24S	330	340	410
32A19R	NX60-N24	270	295		38B20L	NX60-24L	330	340	410
32A19L	NX60-N24L	270	295		38B20LS	NX60-24LS	330	340	410
26A17R		200			40B20L		330		
26B17L		200			40B20R		330		
28B17R		245			42B20R		330		
28B17L		245			42B20L		330		
28B19R	NS40S	245			42B20RS		330		
28B19L	NS40LS	245			42B20LS		330		
32B20R	NS40	270			46B24R	NS60	325	360	420
32B20L	NS40L	270			46B24L	NS60L	325	360	420
32C24R	N40	240	325	400	46B24RS	NS60S	325	360	420
32C24L	N40L	240	325	400	46B24LS	NS60LS	325	360	420
34B17R		280			46B26R		360		
34B17L		280			46B26L		360		
34B19R	NS40ZA	270	325	400	46B26RS		360		
34B19L	NS40ZAL	270	325	400	46B26LS		360		
34B19RS	NS40ZAS	270	325	400	48D26R	N50	280	360	420
34B19LS	NS40ZALS	270	325	400	48D26L	N50L	280	360	420

Battery Model (JIS#)		CCA			Battery Model (JIS#)		CCA		
NEW	OLD	WET	MF	CMF SMF	NEW	OLD	WET	MF	CMF SMF
50D20R		310	380	480	80D26L	NX110-5L	580	580	630
50D20L		310	380	480	85B60K				500
50D23R	85BR60K	500			85BR60K				500
50D23L	85B60K	500			95D31R	NX120-7	620	660	850
50D24R	NT80-S6	390			95D31L	NX120-7L	620	660	850
50B24L	NT80-S6L	390			95E41R	N100	515	640	770
50D26R	50D20R		370		95E41L	N100L	515	640	770
50D26L	50D20L		370		105E41R	N100Z	580	720	880
55D23R		355	480	500	105E41L	N100ZL	580	720	880
55D23L		355	480	500	105F51R	N100Z	580		
55B24R	NX100-S6	435	420	500	105F51	N100ZL	580		
55B24L	NX100-S6L	435	420	500	115E41R	NS120	650	800	960
55B24RS	NT80-S6S	430	420	500	115E41L	NS120L	650	800	960
55B24LS	NT80-S6LS	430	420	500	115F51R	N120	650	800	960
55D26R	N50Z	350	440	525	115F51L	N120L	650	800	960
55D26L	N50ZL	350	440	525	130E41R	NX200-10	800		
60D23R		520			130E41L	NX200-10L	800		
60D23L		520			130F51R		800		
65D23R		420	540	580	130F51L		800		
65D23L		420	540	580	145F51R	NS150	780	920	
65D26R	NS70	415	520	625	145F51L	NS150L	780	920	
65D26R	NS70L	415	520	625	145G51R	N150	780	900	1100
65D31R	N70	390	520	630	150F51R	NT200-12	640		
65D31L	N70L	390	520	630	150F51L	NT200-12L	640		
70D23R	35-60	490	540	580	165G51R	NS200	935	980	
70D23L	25-60	490	540	580	165G51L	NS200L	935	980	
70D23R		500	520	580	170F51R	NX250-12	1045		
75D23R		500	520	580	170F51L	NX250-12L	1045		
75D23L		500	520	580	180G51R	NT250-15	1090		
75D26R	F100-5	490			180G51L	NT250-15L	1090		
75D26L	F100-5L	490			195G51R	NX300-51	1145		
75D31R	N70Z	450	540	735	195G51L	NX300-51L	1145		
75D31L	N70ZL	450	540	725	190H52R	N200	925	1100	1300
80D23R		580			190H52L	N200L	925	1100	1300
80D23L		580			245H52R	NX400-20	1530	1250	
80D26R	NX110-5	580	580	630	245H52L	NX400-20L	1530	1250	

15.2 DIN & EN Standards Rating Chart

Battery Model No.	Standards		Battery Model No.	Standards	
	DIN	EN		DIN	EN
52805	180	240	55057	320	540
52815	180	240	55068	220	390
53517	175	300	55069	220	390
53520	150	240	55218	255	420
53521	150	240	55414	265	450
53522	150	240	55415	265	450
53621	175	300	55421	265	450
53624	175	300	55422	265	450
53625	175	300	55423	300	510
53638	175	300	55427	300	510
53646	175	300	55428	300	510
53653	175	300	55457	265	450
53836	175	300	55529	220	360
53890	175	300	55530	255	420
54038	175	300	55531	255	420
54039	175	300	55545	255	420
54232	175	300	55548	255	420
54312	210	360	55552	255	420
54313	220	330	55559	255	420
54317	210	360	55559L	255	420
54324	220	330	55563	255	420
54434	210	360	55564	255	420
54437	210	360	55565	255	420
54449	210	360	55565L	255	420
54459	210	360	55566	265	450
54459L	210	360	55567	255	420
54464	220	330	55811	360	540
54465	210	360	56012	230	420
54466	210	360	56048	250	390
54469	210	360	56049	250	390
54519	210	360	56068	250	390
54523	220	300	56069	250	390
54524	220	300	56073	250	390
54533	210	360	56077	300	510
54537	190	300	56091	360	540
54545	190	300	56092	300	510
54551	220	300	56111	300	540
54577	220	300	56216	300	510
54578	220	300	56218	300	510
54579	220	300	56219	300	510
54580	220	300	56220	280	510
54584	220	300	56225	300	510
54590	210	330	56311	300	510
54612	210	360	56312	300	510
54801	190	300	56318	300	510
54827	240	360	56322	300	510
55040	265	450	56323	300	510
55041	220	360	56420	300	510
55042	220	360	56530	300	510
55044	265	450	56618	300	510
55046	300	510	56619	300	510
55048	300	540	56620	300	510
55056	320	540	56633	300	510

Battery Model No.	Standards		Battery Model No.	Standards	
	DIN	EN		DIN	EN
56638	300	510	60026	440	720
56641	300	510	60038	500	760
55647	300	510	60044	500	760
56821	315	540	60527	410	680
56820	315	540	60528	410	680
56828	315	540	61017	400	680
57024	315	540	61018	400	680
57029	315	540	61023	450	760
57113	400	680	61047	450	760
57114	400	680	61048	450	760
57217	420	720	62034	420	680
57218	420	720	62038	420	680
57219	420	720	62045	420	680
57220	420	720	62529	450	760
57230	380	640	63013	470	680
57412	400	680	63545	420	680
57412L	400	680	63549	420	680
57413	400	680	64020	325	550
57512	350	570	64028	520	760
57513	350	570	64035	520	760
57531	350	570	64036	460	760
58424	450	760	64317	540	900
58513	320	540	64318	540	900
58514	320	540	64323	540	900
58515	450	760	65513	540	900
58521	320	540	65514	570	900
58522	320	540	65515	570	900
58527	395	640	67043	600	1000
58811	440	720	67045	600	1000
58815	395	640	68021	570	950
58820	395	640	68032	600	1000
58821	395	640	68034	600	1000
58827	400	640	68040	570	950
58833	400	680	70027	630	1050
58838	400	680	70029	630	1050
59017	360	600	70036	570	950
59018	360	600	70038	630	1050
59040	360	600	71014	700	1150
59215	450	760	71015	700	1150
59218	290	480	72512	680	1150
59219	290	480	73011	740	1200
59226	450	760	88038	175	300
59514	320	540	88046	210	360
59518	395	640	88056	265	450
59519	395	640	88066	300	510
59615	360	600	88156	320	540
59616	360	600	88074	400	680
60018	250	410	88092	400	680
60019	250	410			

15.3 YUASA Battery Rating Chart

Battery Model No.	CCA	Battery Model No.	CCA
24-500	500	75A-72	630
34-6MF	500	75-660	660
34-60	525	78A-72	670
34-610MF	610	78-710	710
34-710	710	GR40R-MF	700
35-580	580	GR40R-CMF	820
41-580	580	GTH40	277
55D23R	522	GTH40L	276
58-6MF	530	GTH40S	275
58-60	525	GT50L	356
58-530	530	GTH55DL	356
65-70	700	GTH60L	325
65-730	730	GTH60DL	325
65-900	850	GTH75DL	520
74-60	525	GTH75DR	521
75-6MF	615	GR96R-MF	500
75-72	500	GR96R-CMF	580

15.4 Rough CCA Guide

Given below is a rough CCA ratings guide for any unknown battery model basing on the capacity of the vehicle:

Vehicle Capacity	*Approximate Battery CCA Rating*
1200 ~ 1600 cc	350 CCA
1600 ~ 2000 cc	500 CCA
2000 ~ 3000 cc	650 CCA
3000 cc and above	750 CCA
M. Benz over 3000 cc	760 CCA

16.0 – Alternator Test

This test is to check the MAX and MIN charging voltages output of the alternator at 2000 RPM with all loads ON and 3000 RPM without load. With this test you can determine the alternator's condition when in reference with the vehicle's Service Manual.

Note:

Please test the battery first before doing the Alternator test. A weak or bad battery will affect the results of this test.

16.1 – Start Testing

1. Attach the clips onto the battery terminal posts and the battery analyzer will power up and lights up the LCD display screen as shown (Fig.19).

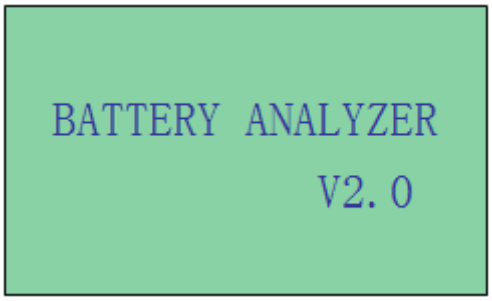


Figure 19

2. It will run through a self-test and when completed it displays the Main Menu as shown: (Fig. 20)

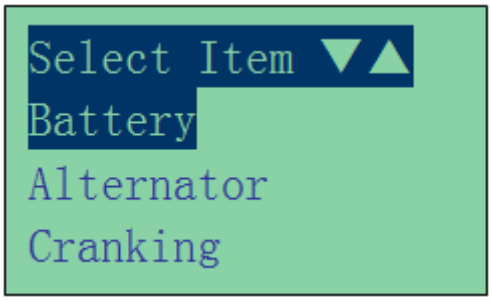


Figure 20

3. Pressing key once will scroll down to the 'Alternator' (Fig.21)

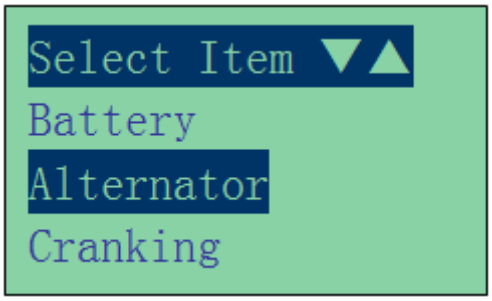


Figure 21

4. Press ENTER key to continue and the display will show: (Fig.22)

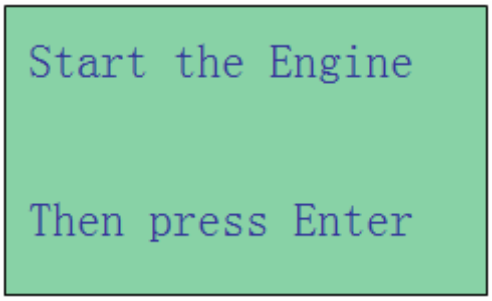


Figure 22

Start the engine and then press ENTER key again and the screen will prompt you as shown below (Fig. 23).

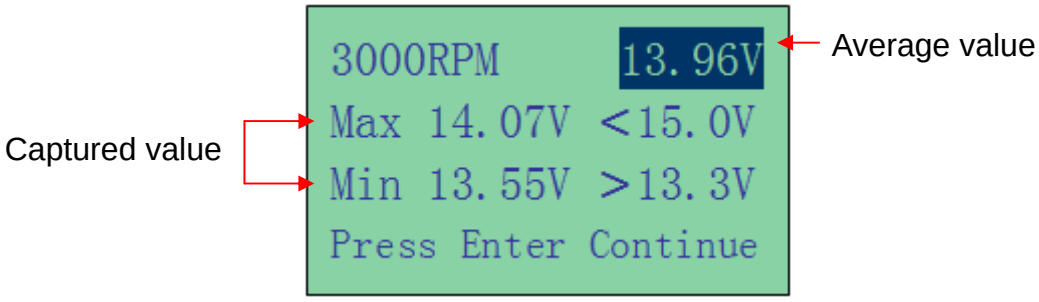


Figure 23

Make sure that all loads (lights, air-condition, etc) are OFF. Rev the engine up to **3000 RPM** and maintain it for 3~5 seconds and then release the pedal. The maximum and minimum voltages values will be captured.

With the captured readings, analysis is done by referring to the limits as indicated that MAX voltage should not exceed 15.0V and MIN voltage should be more than 13.3V.

5. To proceed to the next stage, press ENTER key will enter to the display as follows. (Fig.24)

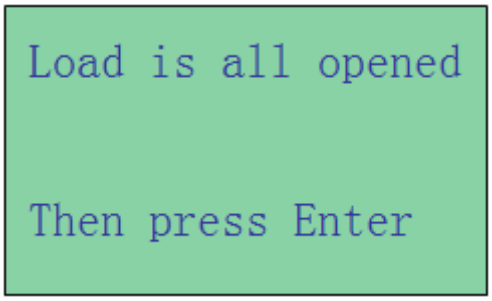


Figure 24

Now, switch ON all loads (Head Lights, Air-condition, Heater, etc) and press ENTER enter key will display: (Fig.25)

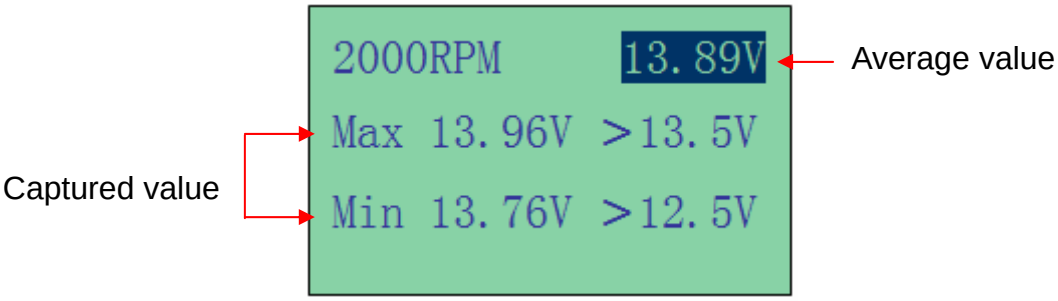


Figure 25

With all loads ON, rev the engine to 2000 RPM and maintain it for 3~5 seconds and then release the pedal. The MAX and MIN readings will be captured. Interpret the results directly on the display - Max. voltage should exceed 13.5V and the Min. voltage should exceed 12.5V for a good alternator during charging.

6. Pressing the EXIT key at any moment will exit and return back to the previous screen.

17.0 – Cranking Test

This test is to check the starter motor condition during cranking. The voltage drop during the cranking cycle will give indication on the condition of the starter motor.

Note:

Please test the battery first before doing the Cranking test. A weak or bad battery will affect the results of this test.

17.1 – Begin Testing

1. From the main MENU, select 'Cranking' by scrolling down using key. (Fig.26)

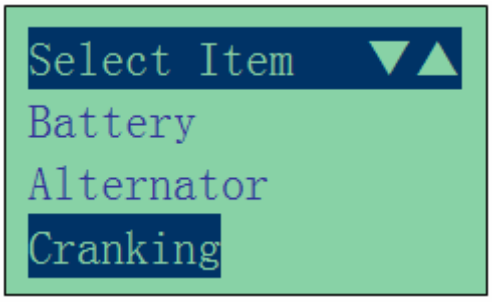


Figure 25

2. Press ENTER key to continue and the display will show: (Fig.26)

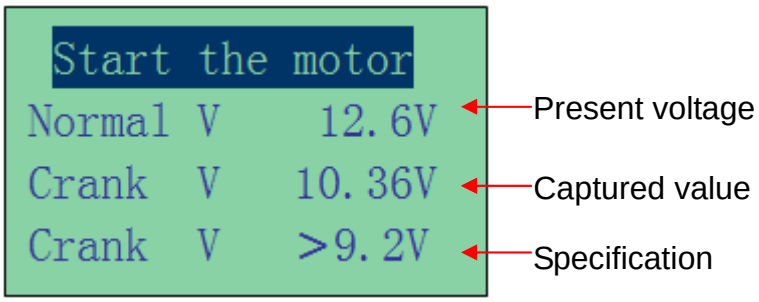


Figure 26

3. Switch the ignition ON and crank the engine until it starts running. The captured value is the voltage drop during cranking and it should indicate more than 9.2V. Anything below this voltage shows that the starter has problem.

4. Pressing the EXIT key at any moment will exit and return back to the previous screen.

18.0 – NOTICE

18.1 – Disclaimer

All information, illustrations, and specifications contained in this user manual are based on the latest information available at the time of printing. The right is reserved to make any changes at any time without obligation to notify any person or organization of such revisions or changes.

Furthermore, the manufacturer or its sales agents are not liable for errors contained herein or for incidental or consequential damages (including lost profits) in connection with the furnishing, performance or use of this material.

This user manual tells how to use and perform the required procedures on vehicles. Safe and effective use of this Battery Analyzer is very much dependant on the user following the normal practices and procedures outline in this manual.

19.0 – Warranty Information

19.1 – Limited Warranty

This limited warranty cover defects in materials and workmanship for a period of twelve (12) months which begins from the date the product is purchased by the end user and is subjected to the following terms and conditions:

1. Within the warranty period, the manufacturer will repair or replace, at their options, any defective parts and return to the owner in good working condition.

2. Any repaired or replaced parts will be warranted for the balance of the original warranty or three months (3) months from the date of repair, whichever is longer.

3. This warranty only extends to the first owner and not assignable or transferable to any subsequent owner.

4. Cost of delivery charges incurred for the repair of the product to and from the manufacturer will be borne by the owner.

5. This limited warranty covers only those defects that arises as a result of normal use and does not cover those that arises as a result of:

    - Unauthorized modifications and repair.
    - Improper operation or misuse.
    - Accident or neglect such as dropping the unit onto hard surfaces.
    - Contact with water, rain or extreme humidity.
    - Contact with extreme heat.
    - Cables that have broken, bent contact pins or subject to extreme stress or wear.
    - Physical damage to the product surface including scratches, cracks or other damage to the display screen or other externally exposed parts.

19.2 - Limitations of Warranty

Other than the foregoing limited warranty, the manufacturer does not make any other warranty or condition of any kind, whether express or implied.

Any implied warranty of merchantability, or fitness for use shall be limited to the duration of the foregoing limited warranty.

Otherwise, the foregoing limited warranty is the owner's sole and exclusive remedy and is in lieu of all other warranties whether express or implied.

The manufacturer or any of its exclusive sales agents shall not be liable for any consequential or incidental damages or losses arising of the loss of uses of this product.

All warranty information, product features and specifications are subjected to change without prior notice.